

# ASSESSMENT OF STRUCTURAL FAILURES IN NIGERIA: A CASE STUDY OF WORSHIP CENTRE

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## **Abstract**

*The frequency of structural or building collapse is on the increase in the developing world. The devastation occasioned by this phenomenon is huge in both human and capital investment. Nigeria like other countries is not immuned against the ugly trend of increase structural failures. A Building or structural collapse may be described as the inability of the entity to hold the load it was designed for available records show that building or engineering or structural failures cannot be attributed to residential structures alone. Bridges have also suffered such fate. This paper will focus primarily on church buildings collapse in Nigeria. The authors of this paper will carry out a review of the immediate as well as remote causes of building collapse and suggest ways to ameliorate and suggest preventive measures that they hope will permanently address the concerns about religious building collapse in Nigeria.*

**Key words-** Building, Structure, Religion, Foundation, Collapse

## **Introduction**

Building collapse or structural failures is a common global phenomenon. The history of engineering failures can be classified into various historical epochs. A superficial analysis of building or man-made fixed structure failures and collapses began in antiquity and can be traced through middle ages to contemporary times. The very first recorded engineering collapse happened in year 266 BC in the ancient town of Greece. The world after the second century structural failure has witness many more with varying degree of consequence. The developing countries are not spared in the narrative of structural failures. According to Akinyemi, Dare & Dabara (2013) who said that Africa has witnessed heart rending structural failures with capital or collateral damage. A good case in point is the synagogue church of all nations in Lagos where the casualty numbers ran into hundreds involving foreign nationals. In the Asian continent a high rise garment factory collapsed in Dhaka, the capital of Bangladesh which sadly recorded casualty figures that doubled the Lagos incidence. The above incidences mentioned

seem to suggest that the casualty figures in third world countries are quite high. However, that statement may be lacking in credibility about the developing world. There exists documentation which shows evidence of casualty figures that rival the one highlighted above in first world countries notably America and Germany to mention but a few. In Nigeria, the trend is on the increase and religious houses or buildings are not left out.

According to Fadamiro (2002) who defined a building as an engineering or structural entity intentionally created to meet a specific human requirement. In the words of Shetima (2004) who posited that a structure can be defined as an enclosure for spaces designed for specific use. According to Odulami (2005) who agreed completely with the first two sources corroborated by given example of structural entities which include but not limited to church or worship centres, schools and such others structures that are man made. The source stated further that a building is that structure meant for human activities, our source added that this structural entity is usually designed with the paramount interest being the safety of its occupants. According to Cook (2012) who argued that buildings can be described as structural entities capable of securing self and transmit load to the ground.

According Hayford (2009), who said in his submission that a building collapse occurs when part or whole body of structure fails and suddenly gives way and falls down wholly or partially, the structure as a result of this failure, could not meet the purpose for which it was designed. According to Ayodeji (2011) who said that when an entire structure fails this is considered as an extreme case of building failure. According to Odulani (2002) the failure of any engineering structure or building could be traceable to compromised or defective elements of the building material used in making up the components parts of such building. Failure in building could also be of two types: cosmetics and structural failure. The former occurs when something has been added to or subtracted from the buildings. The thrust of this paper is to examine causes of building collapse in Nigeria with a view to proffering solutions that will ameliorate the sorry situation.

### **A survey of Church Building collapse**

In this section the authors will take a cursory look at Church building collapse in the global community. This bird's eye view will provide the authors a guide to assessing the situation of Church building collapse in Nigeria.

According to Nellans (2007) the archives of the Sheffield City Council reveals that there are about twenty-five churches building collapse around the world. The collapse of the Dome of Hagia Sophia in the bustling city of ancient Constantinople in the year 558 BC during the Byzantine Empire marks the beginning of the history engineering accidents in the world. The world witnessed other church building collapses in several European cities. France in the year 1284 AD recorded the Beauvais Cathedral accident. The Ely Cathedral Tower Collapse in Cambridgeshire England in the year 1322 AD followed the French incident. Running the gamut between Hagia Sophia accident through the middle ages to contemporary times the world witnessed several devastations in Church building accidents. The immediate and remote causes of those twenty-five Church building collapses around the world did not form part of the focus of the researcher. Suffice it to say that a combination of factors may be responsible as accidents just don't happen. Having established that Church building collapse is not a phenomenon peculiar to the third and Nigeria in particular! We shall at this juncture give our attention to the occurrence of the phenomenon in Nigeria.

According to Pollack (2010) who stated that excessive deflection which results in serious damage to a building component may be referred to as structural failure. On the other hand a sudden dislocation or giving way of a structure is classified as building collapse. According to a recent survey carried out by Windapo and Rotimi (2012) which stated unequivocally that Church buildings account for approximately 13% of building collapse in Nigeria. The year 2014 marks a milestone in the history of Church building collapse in Nigeria and perhaps South Africa too. It is estimated that no fewer than thirty South Africans may have perished in the ill fated six floor guest house belonging to the Synagogue Church of All Nations (SCOAN) which collapsed at Ejigbo suburbs of Lagos in Nigeria. The total number of people killed is said to be at least 115 persons. The vast majority of the foreign casualties were from South Africa, but the nationalities of dozens of other people remained unresolved. According to Fowode (2017) who wrote that in 2016, the Iron rafters of an indigenous church carved in during a consecration service. The founder of the church who was present in the church as at the time of the accident escaped unhurt. This incident is estimated to have claimed at least 100 lives. It is important to note that most church building collapse are not often reported or recorded, except where there exist casualties which would make near impossible to keep out the involvement of relevant government agencies.

According to Abimbola & Rotimi (2012) who speculated that the geographical spread of building collapses in Nigeria suggests a high prevalence in the southern part of Nigeria which

is credited with about 82% of reported case in Lagos. The same source states that only about 9% of structural failures are recorded in Abuja. 5% cases are speculated to occur in the South-South of Nigeria. Our sources further ascribed another 5% to the South East region of Nigeria. The lowest allocation went to the joint regions of North-Western and North-Central Nigeria which got barely 4%.

According to McCullough (2007) who posited that there are examples of church building destruction that cannot be attributed to faulty materials or engineering failure. A case in point is the most expensive Church construction historically recorded in human existence. It is speculated to be the King Solomon's Temple. To help the audience get a glimpse of how expensive the Temple cost may have been, consider the following. The first is that it is speculated that seven years were invested in building the temple or house of God as it was called in biblical times. The second mind blowing speculation is the fact that the city of Jerusalem was made bustling with activities as more than 180,000 able bodied men worked daily at the temple site. The third myth surrounding the temple's construction suggests that at least 30,000 Jewish nationals were employed in the construction while a whopping estimate of 150,000 canaanites were engaged in building the Solomon Temple. According to Hayford (2009) who said that this peculiar temple stood for 400 years before it was destroyed in 586 BC. It is curious to note that this magnificent edifice built by king Solomon never collapsed as result of construction inadequacies, but was deliberately destroyed by Roman General Flavius. According to Marley (2008) who said that during the reign of Joseph I of Portugal, Lisbon was struck by a devastating earthquake also known as the Great Lisbon Earthquake in November 1<sup>st</sup> 1755 at 9:40 am on 'All Saints Day', when all the churches at Lisbon were filled to capacity with worshipers. 15,000 people lost their lives and several churches were destroyed. suffice it to say that these destruction of churches at Lisbon was not due to engineering or construction failures but natural forces. The foregoing seems to suggest that causes of building collapse and in the case of this study Church building collapse are traceable to a combination of factors.

Table 1 below is a selected list of religious building collapse across the world.

#### **. List of Structural failures of Church Buildings across the Globe**

<i>Date</i>	<i>Name</i>	<i>Location</i>	<i>Type</i>	<i>Casualties</i>
1284	Chior of Beauvais	France	Strutural Failure	NA
1322	Ely Cathedral	England	Strutural Failure	NA
1382	ST. Mary's Church	Germany	Strutural Failure	NA
1500	Malmesbury Abbey	England	Strutural Failure	NA

1529	St Elizabeth's Church	Poland	Strutural Failure	NA
1549	Lincoln Cathedral	England	Strutural Failure	NA
1573	Baeuvais Cathedral	France	Strutural Failure	NA
1577	<a href="#">Martinikerk</a>	Netherlands	Strutural Failure	NA
1625	St Olaf's church	Sweden	Strutural Failure	NA
1647	St Mary's chruch	Germany	Strutural Failure	NA
1661	St Reinoids Church	Dortmund	Strutural Failure	NA
1666	St Peter's Church	Latvia	Strutural Failure	NA
1674	Dom Church	Netherlands	Strutural Failure	NA
1697	St Michael's Church	Romania	Strutural Failure	NA
1700	Abbaye Church	France	Strutural Failure	NA
1721	St Peter's Church	Latvia	Strutural Failure	NA
1754	Tower Church	Germany	Strutural Failure	NA
1763	St Michael's Church	Romania	Strutural Failure	NA
1777	church of St. Mary Magdalene	Posen, Prussia	Strutural Failure	NA
1861	Chichester Cathedral	England	Strutural Failure	NA
1868	St Peter's church	Germany	Strutural Failure	NA
1993	St Maria's Church	Germany	Strutural Failure	NA

Source: Wikipedia.com

### **Causes of Building Collapse in Nigeria**

According to Abimbola & Rotimi (2012) who posited that from the foregoing there are many factors natural and man-made that are the culprits responsible for global building collapse. Our source stated further that as established above from our earlier discussions natural phenomenon such as earthquakes can trigger building collapse. The Great Lisbon Earthquake as the event which happened in Lisbon during the reign of Joseph I of Portugal in 1755. All the structural failures recorded on the said day may not be attributed to either incompetence of man or defective materials used in the construction by the engineers. We mould like to mention that earthquakes may not be the only natural phenomenona which can result in building failure. There are natural forces that are as ferocious as the earthquake such as typhoons, cyclone, hurricanes and Tornadoes to mention but a few. these are forces which man has absolutely no control over but are violent enough to trigger building failure. Our focus in this section off this treatise is to acertian those building failures that can be attributed only to man. While these man-made phenomenon results in horrifying disasters which very likely is as a result of man's negligence or incompetence in areas such as building design, quality of building materials, poor workmanship, the use of unskilled labour and non-compliance with construction regulation or by-laws.

### **Poor Quality of Materials and Inadequate Structural design**

The authors would like to give attention to remote and immediate causes of building collapse specifically in Nigeria. According to Oyewale (1992), who opined that the use of poor quality materials is said to constitute about 10% of the factors leading to cases of building collapse in Nigeria. According to our sources who said that the report on Synagogue Church of all Nation sixth storeys building collapse as published on the internet by Wikipedia.org the following observations were made.

The first observation as contained in that report indicated that three government agencies which include but not limited to the Nigeria Building and Road Research institute (NBBRI), the Council for the Regulation of Engineering in Nigeria (COREN) and the Building Collapse Prevention Guild (BCPG). They reported after they examined the site and found that inadequate beams of 750mm by 225mm were used instead of 900mm by 300mm as stipulated by standards.

The engineers were also indicted for inadequate reinforced columns of 10 x 20 bars which were used instead of 12 x 25 bars or 20 x 20mm bars that would have met the required specification for that particular structural designed. Other discovery made included the failure the engineers to introduce rigid zones for bracing the structure since the original plan did not design unbraced structure therefore additional frames were required as stipulated by standards. Further indictment include failure of the engineers to provide movement joint to compensate for strain which the structure would be subjected. The final indictment as observed by the above mentioned regulation agencies of the federal government was the use of under signed beams. According to Fadamiro (2002) who writing in line with the three government agencies said that in addition to the anomalies reported other design deficiencies include calculation errors, bearing support problems, secondary stresses, elastic cracking, and temperature and shrinkage problems.

### **Changes and alterations**

Changes and alterations in existing building contribute substantially to building structural failure. Sudden change in use or errors in assumed loading in building often lead to the crushing and collapse of concrete column and footing or other foundation members. According to Ayodeji (2011) who opined that the most common form of foundation failure occurs due to abnormal loading situations especially in structure being converted to new use or having additional floors. Creating additional rooms on suspended floors or changing the use of building for example converting residential to mini-factory whereby heavy duty equipment are

placed on suspended floors. When vibrations are generated on suspended floors by breaking of slabs as well as exposing old foundation to flood and erosion can easily lead to structural failures.

### **Foundation failure**

According to Samer (2012) who said that:-

Foundations of building structures are essential elements as they transfer building loads and forces into the ground. These will include all the loads apply on the building which will be diverted and spread over a sufficient area to utilize the maximum allowable resistance of the soil. All loads transmitted to the underlying soil cause generally cause movements. Normally there is the allowable minimum movement asserted by the project's geotechnical engineer and also by the regulation provided in the building code. Generally, foundations are classified as either shallow foundations or deep foundations (P. 1).

According to Fadamiro (2002) whose position was essentially repeated by Samer (2012) said a building structure can collapse if constructed on faulty or under designed foundation. Foundation of a building is that part of walls, piers or column in direct contact with and transmitting load to the ground. Building foundation failure can be caused by construction of foundation on poor load bearing sub-soil, building not uniformly loaded, soil erosion, uneven earth movement and poor foundation construction. In addition as stated by Marshal, Worthing & Heath (2003) who opined that proximity of trees and shrubs to building can result to foundation failure due to their physical presence and strength. As the trees grows the radius of the root system increases and the individual roots grow in size. This, in time, can lead to the displacement of the surrounding sub-soil, upwards and outwards pressure on foundations and walls in the vicinity of the root and even growth through underground walls of softer or weaker materials as captured in figure 1 below



Fig. 1 -Root growth expands. It applies pressure upwards and outwards on sub-soil and building

### Faulty Construction

According to Okuntade (2014) who opined that faulty construction involves: -

The use of damaged, unfitting or unsuitable materials undermines the functionality of constructed elements, leading to defects (Assaf et al. 1995). Josephson and Hammarlund (1999) revealed that approximately 20% of defect costs originated from impaired materials. .... deviations of the order of centimetres or millimetres). Assaf et al. (1995) refers to these as defects due to inadequate measurements. Although such defects often do not seem highly severe, a handful of cases in Dubai's construction industry have proven that these errors can have fatal consequences. ...

... The contravention of these instructions include, for example, neglecting a drawn detail, not adopting the intended design, or placing an element in a position that deviates from that instructed in drawings. No matter the degree of excellence at which such tasks are accomplished, since they do not conform with the instructed requirements, they are considered quality failures (defects) (Crosby 1984; Assaf et al. 1995;Kärnä 2004) that entail rework (Abdul-Rahman 1995;Ashford 1992). Instruction contravention acts primarily originate from violations, though they can also be rule-based errors. (P. 10). The success of a building project depends on its performance, which is measured based on the cost of maintenance and the quality and standard of workmanship. Hence, the maintenance cost of a building during its functional life could outweigh the initial cost of a new building if maintenance has not been incorporated during the planning stage of the project. It is therefore of paramount importance to note that any decision made at the planning and construction stage of the project could have a substantial effect on the cost of maintenance. The paper seek to identify the defects caused by faulty construction on maintenance, a total of 115 structured questionnaire were randomly distributed to three (3) groups of respondents Builders, Architects and civil engineers eighty(80) were completed and returned. The severity index (SI) was used to rank the most severe defects on maintenance. While, the kruskal Wallis test, show that there were comparison and no significance difference in the opinion between the respondents. The results reveal according to the rank by the architects and builders that insufficient reinforcement bar concrete cover is the most severe defects while the civil



engineers rank non-compliance with specification as the most severe defects. The study concludes that ensuring quality during construction process is dependent on teamwork and also the performance of contractor's should be monitored to avoid defects, mistake or spot inspection. (P. 12).

According to Olagunju, Aremu & Ogundele (2013) who argued that previous studies have shown that faulty construction methodology contributed up to 40% in buildings structural failures, hence building collapse occurrences. In several occasion contractors fail to build in accordance with plans and specifications. Most religious organization make use of direct labor, volunteers and allows religious sentiments to influence the choice of contractors. Consequently, instruction and monitoring of construction materials and actual construction is poor. Moreover, Mix ratio by the engineers and the incompetence of supervisors (which in most cases are church leader or committee chairman) may aid the contributors to carry out some of their evil that often lead to incessant building collapse. A study carried out by Mathebula & Small wood (2017) revealed that most churches undertake to build the structures without complying with the bye laws or regulations, used unqualified worker and the volunteers are not even trained in hazard identification and risk management. Somehow, there is this belief among believers that God will always protect the people and the building regardless of their poor workmanship or input.

### **Poor Maintenance**

According to Suffian (2013) who writing on the East Asian country called Malaysia said that it is one of the fastest growing economies in South East Asia with first class infra-structures. The government of Malaysia is really concern about the importance of building maintenance aspect. Even though the concept of building maintenance has already existed in Malaysia since modern buildings were constructed the typical understanding and approaches require changes in order to suitable for current realities and demands. Our source stated further that maintenance of building is a complicated and costly process but if it is carried out wisely it could save money and potentially extend life span of the building. The maintenance process must involve two types of maintenance. The first is preventive maintenance and the second is corrective maintenance. Of the two, preventive maintenance is more crucial and those who involve in the development of building must understand its importance right from the beginning of the projects. Architects, engineers, planners and all involved in the real estate industry should study the potential relevance and importance of every aspect of maintenance and operational problem before working out the design.

According to Agbafor (2014) who said that poor building maintenance or lack of maintenance culture can result in the weakening of the engineering structure. It is worse when unplanned maintenance approach is the culture or practice of the building owner. However, Deterioration in building starts from the time they are completed through the operational phase. The phenomenon of deterioration in building, is unavoidable, nevertheless, the rate at which building deteriorate can be controlled or reduced through proper building maintenance practice.

### **Undue Interferenc**

According to Adetunji (2017) who wrote about interferance of Church leadership om the work of Church Building Committee and make them act against professional advice constitute about half the total percentage of the urgly incidence in Nigeria. Sometimes the client or religious leader makes serious changes and variations at advanced stage of construction with the contractor without seeking building consultants' advice. And the consultant overlooks or fails to challenge the situation due to fear of 'spiritual authority'.

### **Effects of Building Collapse**

Loss of human life has become a common report of most of the collapse building incidents in Nigeria. A study by Arayela and Adam (2001), about two hundred and seventeen (217) people were reported dead with many injured from only fifteen selected cases of building collapse between 1974 and 2001. Victims could be bread winners, taking care of large family members, thereby leading to psychological trauma.

According to Olagunju, Aremu & Ogundele (2013) who opined that apart from loss of life highlighted above, there also lose of Materials and Capital Investments. In the event of any building collapse, components and materials are damaged beyond re-use Capital investments are not recoverable, leading to bankruptcy and high economic implications to the nation's economy. Other implications or effects includes but not limited to;

- Loss of reputation and integrity of the religious organization.
- Court litigations, claims and counter claims.
- Loss of church or religious members

### **Recommendations**

According to Vitruvius (cited by Farah, 2009) there are three simple rules of architecture – utility, strength and beauty. According to Rhose (2001) who stated that there are three natural

laws of Catholic building construction. They are as follows, firstly a Catholic Church building must have verticality. Secondly the Catholic Church building must have permanence and lastly the Catholic Church building must the quality of iconography. While it is true that the three policy statements of the institution are vital. The policy on permanence is most relevant to the discussion on curbing the menace of building collapse in Nigeria. The relevance of permanence is based upon the idea that, “the church, is a building that will serve generation after generation, transcending time and culture, must be constructed of durable materials” (P 12). According to Mathebula & Smallwood (2017) who are the viewa that once a master builder has laid a foundation on the rock and built a strong edifice, that edifice will stand for all time as seen from the temple that was built by King Solomon. Yet a number of ecclesiological studies do not focus on the health and safety management of the pilgrims or worshipers. From the foregoing analysis and discussion, the following recommendations should be taking into consideration by all the stakeholders in building industry including religious leaders in Nigeria. These include and suffice it to say the list is by no means exhaustive,

- ❖ Religious or Faith-based organisations should have a Health and Safety Committee that would oversee the health and safety of their congregants, plants and buildings/auditorium.
- ❖ Religious or Faith-based organisations should do risk assessments periodically on existing worship centres or buildings.
- ❖ The government should appoint building inspectors to monitor the health and safety of faith-based structures especially centres used for camping and conferences.
- ❖ Urban or Town development agencies at various levels of government (commission, Board, Authority) should enforce control of building works (churches and mosque inclusive) in their localities as laid down in urban and regional planning decree 88, of 1992 and as in section 13 of National Building Code 2006.
- ❖ All the professional bodies associated with the building industry in Nigeria, such as Nigerian Institute of Architects (NIA), Architect Registration Council of Nigeria (ARCON) and Nigerian Society of Engineers (NSE) as well as Council of Registered Engineers (COREN) should find a way of curbing, if not to stop quarks operations in building industry.
- ❖ Workmen with the appropriate training should be employed for building works especially those working on the structural members, instead of always depending on unskilled church volunteers.

- ❖ The design team in any building work should be very careful when selecting supplier of building materials i.e. nominated supplier. Materials supplied to site by such should also be checked and vetted appropriately in conformance to the contract specification. The religious leaders should avoid undue interference and spiritualizing the selection of contractors and construction process.
- ❖ Religious leaders should undergo training in health and safety.

### **Conclusion**

The safety of faithfuls has to occupy the highest spot on the scale of God's preferences. If God were a business entrepreneur the preservation of human life would be the core of the entrepreneurial service. We could safely conclude on the above premise that for anyone to die while performing spiritual obligation would tantamount to bad business ethics. It is a given that God is a God of order and principles. The bible is replete with numerous examples but suffice it to say that Noah construction the Ark is a case in point. The Patriarch was commanded to build to divine specifications which was strictly obeyed to the latter. It is a fact that Nigeria has witnessed collapsed buildings in various dimensions, either those under construction or those already in existences. Religious buildings should be a safe haven for the collective good of the congregants. This simply means that when faith based organisations erect building for the purpose of worship; the buildings should be compliant with all construction regulations. By taking short cuts and having a form of beliefs that negate construction principles /ethics; religious organizations are exposing their members to major hazards and danger. As discussed above, building collapse are more as a result of poor workmanship as well as the failure of church authorities to comply with construction regulations and bye-laws. The collapse of these buildings produces more casualties due to huge number of people who attend those services and some incidence are neither reported nor recorded. Religious leaders should look at the scope of their responsibilities as far as the health and safety of their church members is concerned. The clergy, religious and laity should ensure that the structures that are constructed for religious purposes are safe and durable. The government has a role to play by ensuring that all building plans tendered by any developer for approval must comply with the Nigeria's new building code and local bye laws and regulations. Finally, with regards to safety, nobody works alone. It is a joint responsibility. Hence, all parties should be held accountable right from the Church leadership to the regulators who should have taken reasonable steps to give professional advice and where need be, exercise their right to serve enforcement notices before a catastrophic incident happens.

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